Radiation Safety at LLNL

General Employee Radiological Training

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University of California
Lawrence Livermore National Laboratory

Contents

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General Employee Radiological Training (GERT)

A variety of radioactive materials and radiation-generating devices (RGDs), such as x-ray machines, electron beam devices, and accelerators, are used at the Lawrence Livermore National Laboratory (LLNL) to accomplish its research and development mission. To ensure individuals are aware of the potential radiological hazards associated with these activities, basic radiological training, otherwise known as General Employee Radiological Training (GERT), is required before individuals are allowed unescorted access into areas posted with the radiation symbol (see Fig. 1). Additionally, GERT is required before individuals are allowed to receive an occupational dose in these areas. Further radiological worker training must be completed prior to unescorted assignments as a radiological worker.

For LLNL and supplemental labor employees, GERT is initially provided as part of New Employee Orientation. The biennial retraining requirement is satisfied by reading this booklet or by completing the web-based course (HS0001) online at http://www-training.llnl.gov/wbt/. Retraining is automatically documented in the Livermore Training Records and Information Network (LTRAIN) when this booklet is mailed out in October of alternating years. Other individuals (e.g., visitors, other contractors) must sign and carry the GERT card located at the back of this booklet or complete the web-based course to document their training.

Individuals who have completed GERT may escort untrained workers into areas requiring GERT training. The escort is responsible for ensuring the untrained worker complies with the posted radiation safety requirements.

This booklet provides general information about radiation and the controls LLNL implements to ensure the safety of workers, visitors, and the environment. The area supervisor or the ES&H Team health and safety technician can provide specific information about your work area.

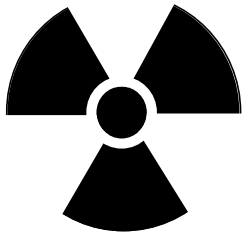


Figure 1. Radiation symbol.

What Is Radiation and Where Does It Come From?

Radiation can be either ionizing or nonionizing. Nonionizing radiation, such as laser light and microwaves, is covered in the booklet, *Safety at LLNL*. The type of radiation referred to in this booklet is **ionizing radiation**–invisible particles or waves of energy emitted from radioactive atoms or RGDs. The common types of ionizing radiation are alpha, beta, neutron, x-ray, and gamma radiation. Some atoms (e.g., uranium and thorium) are naturally radioactive; others (e.g., tritium and iodine-131) can be made radioactive in reactors or accelerators.

If radiation energy is deposited in a person, he or she receives a **radiation dose**. Radiation doses are measured in units of millirem (mrem) or rem. One thousand millirem is equal to one rem (1000 mrem = 1 rem).

Background radiation is radiation from our natural environment. It primarily comes from cosmic rays, radioactive material in the earth, ingestion of naturally occurring radionuclides in food (such as potassium-40), and inhalation of radon gas. In the United States, the average background radiation dose is 300 mrem / year. Manufactured sources of radiation contribute an additional dose of approximately 60 mrem / year. Of this dose, about 54 mrem / year is from medical procedures (e.g., x rays and certain diagnostic tests). Consumer products, such as lantern mantles and smoke detectors, contribute roughly 5 mrem / year. Fallout radiation that is still present in our environment contributes less than 1 mrem / year. Figure 2 shows typical annual radiation doses in the United States.

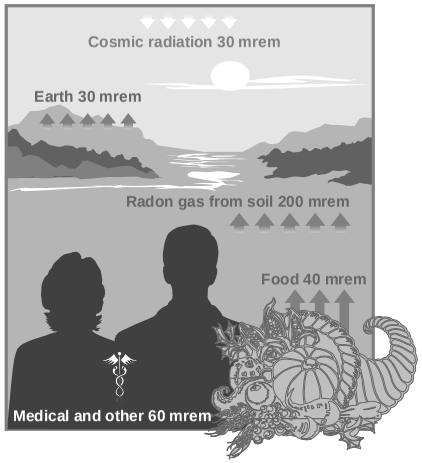


Figure 2. Average annual radiation doses in the United States from natural and manufactured radiation sources.

Occupational Dose Limits

The Department of Energy's (DOE's) occupational radiation dose limits[1] are shown in Table 1.

Table 1. Annual occupational dose limits.

Group	Dose limits
General employees (any DOE worker or contactor)	**5000 mrem/y**
Embryo/fetus of a declared pregnant worker*	**500 mrem/gestation**
Minors and members of the public entering areas posted with the radiation symbol	**100 mrem/y**

*Contact the Health Services Department for reproductive health information.

Using the integrated safety management process, LLNL strives to keep radiation doses to workers, the public, and the environment below the legal dose limits and as low as reasonably achievable (ALARA), taking into account technical and financial considerations. The Laboratory is very successful in keeping occupational doses ALARA. Figure 3 shows the external radiation doses received at LLNL in 1998. Note that more than 99 percent of workers did not receive any occupational radiation dose. This dose distribution is typical at LLNL. For perspective, Table 2 shows the average annual dose received by workers in other occupations.

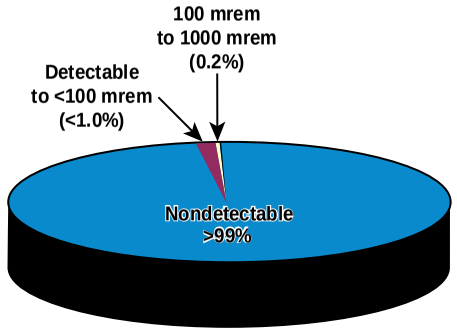


Figure 3. External occupational radiation doses received at LLNL in 1998.

Table 2. Annual radiation dose by occupation.

Occupation	Average Dose (mrem/y)
Airline flight crew member	**~500**
Nuclear power plant worker	**310**
DOE/DOE contractor	**75**
Medical personnel	**70**

Risks Associated with Radiation Exposure

The primary risk from radiation exposure is an increased risk of cancer. The amount of risk depends on the amount of radiation dose received, the time over which the dose is received, and the body parts exposed. Although scientists assume low-level radiation doses increase one's risk of cancer, medical studies have not demonstrated adverse health effects in individuals exposed to small chronic radiation doses (i.e., up to 10,000 mrem above background).

The increased risk of cancer from occupational radiation exposure is small when compared to the normal cancer rate in today's society. The current risk of dying from all types of cancer in the United States is approximately 20 percent[2].

If a person receives a whole-body radiation dose of 25,000 mrem over the course of a lifetime, his or her risk of dying from cancer is presumed to increase to 21 percent[3]—a one percent increase. Figure 4 shows the natural incidence of cancer fatalities and genetic (or heritable) birth defects as well as the estimated risk of radiation exposure causing a cancer fatality or a genetic effect. (A genetic effect impacts an individual's eggs or sperm so that an effect is seen in the exposed individual's offspring.) The data on heritable effects are based on animal studies because no heritable effects from radiation exposure have been observed in humans.

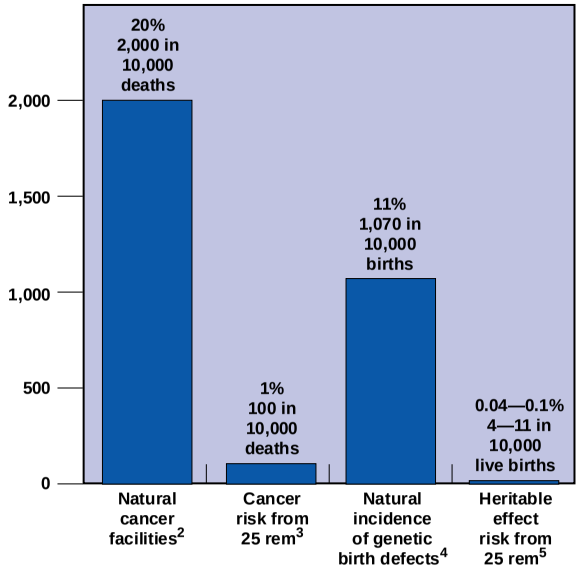


Figure 4. Estimated risks.

Protecting the Embryo/Fetus

Although heritable effects from radiation exposure have not been observed in humans, the embryo/fetus is known to be more sensitive to radiation than adults. Therefore, individuals who are planning a pregnancy or who suspect (or know) that they are pregnant, are strongly encouraged to notify the Health Services Department (ext. 2-7459) as soon as possible. Health Services will arrange to have the workplace evaluated—confidentially if desired—for potential hazards to the embryo/fetus. Workplace or task modification is typically not necessary because 99 percent of all LLNL personnel receive only background levels of radiation.

For additional information on the reproductive effects of radiation and other toxic agents, see *Reproductive Health: Effects of Chemicals and Radiation on Fertility and the Unborn Child* (LLL-TB-89). This pamphlet is available from the Health Services Department.

Monitoring Radiation Exposures

A **dosimeter** measures the dose a person receives from external sources of radiation. Employees and supplemental labor are required to wear an LLNL-issued radiation dosimeter while onsite. Visitors and temporary contractors are required to wear an LLNL dosimeter if they enter areas posted with the radiation symbol. If you need a dosimeter and don't have one, call "2 GET 1" (ext. 2-4381).

The type of dosimeter routinely used at LLNL is a thermoluminescent dosimeter (TLD). These dosimeters contain crystals that absorb energy when exposed to ionizing radiation and release that energy in the form of light when heated. The amount of light released from the dosimeter is proportional to the radiation dose received. Figure 5 shows an exploded view of an LLNL dosimeter packet.

Figure 5. LLNL dosimeter packet (exploded view).

Dosimeter packets should be worn and cared for as follows.

1. Wear your dosimeter facing out on the upper part of your body. Make sure the plastic flap with the LLNL logo covers the dosimeter, but do not allow anything else to cover it (including plastic cards).
2. Do not wear your dosimeter at other sites. If a dosimeter is required, that site will issue you one.
3. Do not expose your dosimeter to radiation outside your work environment (e.g., dental x rays and medical procedures).
4. If you have received (or will be receiving) radiopharmaceuticals for medical diagnosis or treatment, notify Hazards Control since some medical procedures result in a positive dosimeter reading. If you are not sure about the type of treatment you are receiving, ask your physician.
5. Promptly notify Hazards Control if your dosimeter is exposed to excessive heat or moisture, or if your dosimeter becomes lost or damaged.
6. Do not wear another person's dosimeter.

The Laboratory provides all individuals with a radiation dose report if their dosimeter indicates they received an occupational radiation dose. Laboratory workers receive an annual summary of their dose even if no dose is received. Visitors who indicate they will conduct radiological work while at LLNL are also provided with "zero" dose reports. Termination dose reports are provided upon request to all workers. Anyone who has worn a dosimeter at LLNL may obtain a copy of his/her dose report from the Hazards Control Department's Personnel Dosimetry Team.

Workers who routinely handle dispersible radioactive material may be required to participate in LLNL's internal dose monitoring program. This program assesses internal dose by measuring radioactivity in urine or by measuring the radiation emitted from the body. Positive internal doses are reported to the individual and are included in the individual's personnel dosimetry record.

Basic Radiation Safety Controls

Engineered controls such as shielding, ventilation, alarms, warning signals, and material containment are the primary means of controlling radiation dose at LLNL. Administrative controls—such as signs, procedures, dosimetry, and training—supplement the engineered controls.

External Radiation Protection

An external radiation dose is delivered from a source located outside the body. You may encounter low-level radiation fields (i.e., less than 5 mrem/hour) in radioactive material areas, x-ray areas, accelerator areas, and radiological buffer areas. While in these areas, you can minimize your external radiation dose by

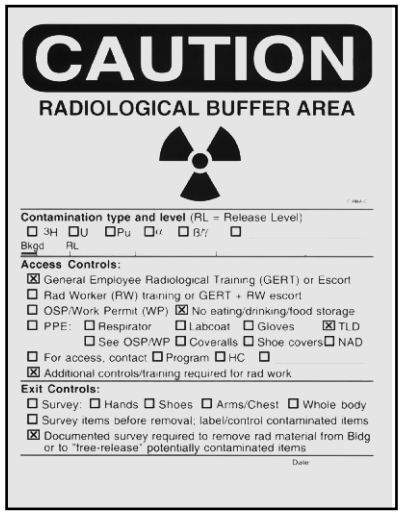
- Minimizing the time you are exposed to radiation sources.
- Maximizing your distance from radiation sources. The radiation level decreases significantly with increasing distance.

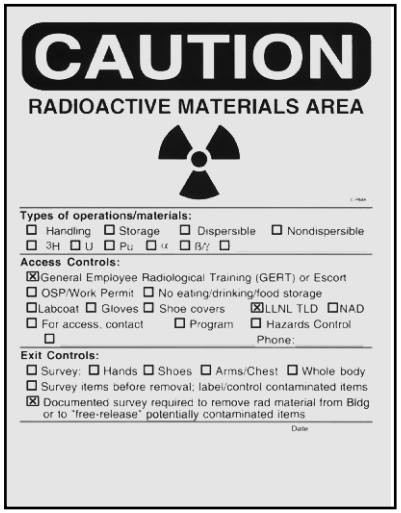
Internal Radiation Protection

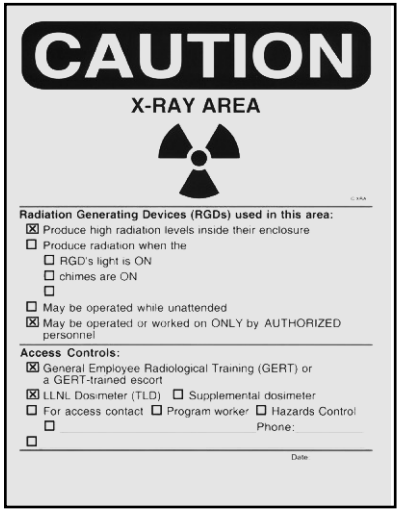
Radioactive materials located inside the body delivers an internal radiation dose. Intakes of radioactive material could result from inhalation, ingestion, injury, or in some cases, absorption through the skin. Everyone gets some internal radiation dose from their diet, but LLNL strives to prevent internal occupational exposures by controlling releases of airborne radioactive material and prohibiting eating or drinking in areas where dispersible radioactive materials are handled. In addition, workers are required to use personal protective equipment (e.g., lab coats and gloves) to keep radioactive material off of their clothing and body.

Radiation Signs

Signs with the radiation symbol are used to identify controlled areas and to inform workers of potential radiological hazards. Figure 6 shows examples of the areas you may enter after completing GERT, or with a GERT-trained escort. Additionally, GERT is required before workers may receive occupational exposure in these areas. Figure 7 shows the areas you may NOT enter without additional radiological training unless you complete GERT and are escorted by an LLNL-trained radiation worker.







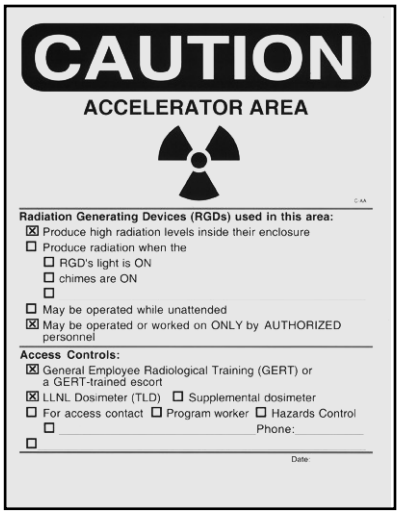
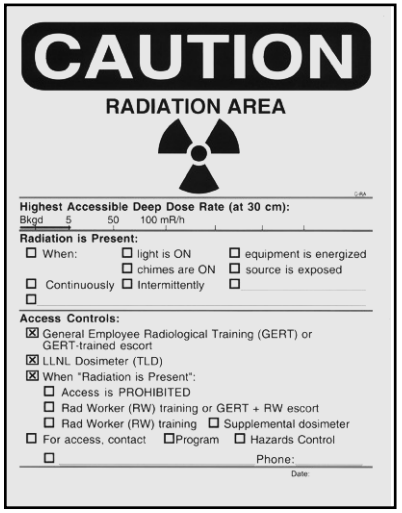
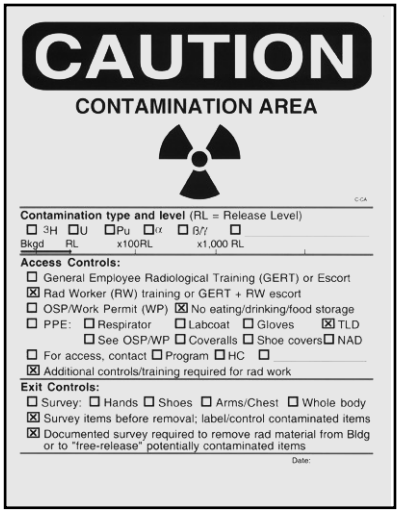


Figure 6. Unescorted access to areas posted with these signs requires GERT.





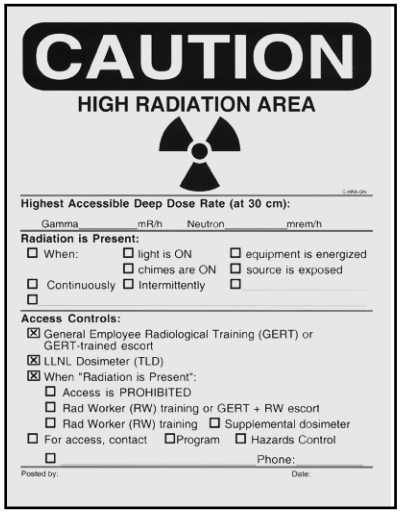


Figure 7. Unescorted access to areas posted with these signs requires additional radiological training.

Acquiring and Transporting Radioactive Material

The acquisition of radioactive material, whether purchased, borrowed, or provided by others (e.g., other DOE contractors, universities, or companies) must be approved by the Hazards Control Department. Radioactive material that is received onsite must be processed by the Materials Management Section (in the B231 Vault) and be properly labeled and controlled.

Transfer of radioactive materials (including contaminated items) from a facility at LLNL requires a coordinated effort between the program, the ES&H Team, and depending on the amount of material involved, either Materials Management or Hazardous Waste Management. This approach ensures that the material is properly packaged, monitored, and controlled. Controls for moving radioactive material are contained in the ES&H Manual, Volume II, "LLNL Radiological Safety Program for Radioactive Materials" (Health and Safety Manual Supplement 33.42).

Responsibilities

You play a critical role in ensuring your own safety and the safety of those around you. If you have safety concerns, discuss them with the area supervisor, the responsible individual, or the ES&H Team before beginning the work.

Workers whose job assignment involves work with radioactive materials or radiation-generating devices must attend the required training and be familiar with the applicable safety plans, processes, and equipment to be used. Supervisors and managers must provide a safe work environment and ensure that the requirements in the ES&H Manual, Volume II, "Occupational Radiation Protection" (Health & Safety Manual Chapter 33) and its supplements are implemented. Visitors are responsible for obeying all posted signs, attending required training, and reporting unsafe conditions to their hosts.

Other Sources of Information

The Environmental, Safety, and Health Manual. Review *ES&H Manual,* Volume II, “Occupational Radiation Protection”(formerly H&SM C33) and the related supplements online at
http://www.llnl.gov/es_and_h/esh.html

Radiation safety courses and computer-based training. For course information, contact your training coordinator or the Hazards Control Computer-based Training Center (ext. 3-1094).

Your ES&H Team. The ES&H Team health and safety technician assigned to your facility will answer your questions or refer you to a health physicist. You can find the phone number for your ES&H Team health and safety technician on the Hazards Control Assistance sign located near the hallway phone(s) in your building.

References

1. U.S. Department of Energy, 10 CFR 835, “Occupational Radiation Protection.”

2. American Cancer Society, *Cancer Facts and Figures*—1995 (1995).

3. International Council on Radiation Protection (ICRP), *Recommendations of the International Commission on Radiological Protection,* Publication 60 (1990).

4. The National Research Council Committee on the Biological Effects of Ionizing Radiation, *Health Effects of Exposure to Low Levels of Ionizing Radiation,* BEIR III (1980).

5. The National Research Council Committee on the Biological Effects of Ionizing Radiation, *Health Effects of Exposure to Low Levels of Ionizing Radiation,* BEIR V *(1990).*

Emergency Procedures

If an accident or incident occurs in a radiological work area:

- Get help. Contact your ES&H Team for minor incidents. For more serious conditions, call 911 (or 925-447-6880 from a cellular phone).
- Don't move injured people unless it is absolutely necessary.
- Secure the area and keep people from re-entering.
- Administer first aid only if you know how and it will not endanger you or the victim.
- Notify the responsible individual.
- Follow the instructions of emergency response personnel (e.g., contamination monitoring, collection of nasal swipes.)

When reporting an emergency, remember to give the dispatcher the following information:

- What happened and where it happened, including the building and room number.
- An injury assessment.
- Your name and the extension you are calling from.

Remain on the line until the dispatcher tells you to hang up.

Wait at the scene until the Fire Department, a Protective Service Officer, or an ambulance arrives. Tell the emergency personnel about the hazards associated with the area. Assist emergency responders if requested to do so.

Lawrence Livermore National Laboratory
General Employee Radiation Training (GERT) Card

_____*has read and understood the LLNL GERT booklet (October 1999)*

This training allows unescorted access into any area posted with the radiation symbol but does NOT allow unescorted entry into an area posted as "Radiation Area" or "Contamination Area". It also meets the LLNL GERT retraining requirements for LLNL workers and the initial radiation safety training for visitors. This training is valid for 24 months from the date the card is signed.

Visitors should carry this card to provide proof of GERT training.

*Date signed*_____